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EXPERIMENTS

WITH

PERMANGANATE OF POTASH,

SHEWING ITS USE

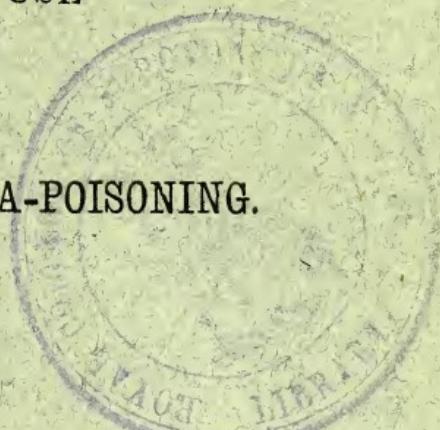
IN THE

TREATMENT OF COBRA-POISONING.

BY

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EXPERIMENTS WITH PERMANGANATE OF POTASH IN SNAKE-POISONING.

By VINCENT RICHARDS,

Late Member of the Snake-poison Commission.

1ST SERIES.

Cobra-poison.

I.

November 16th.—Hypodermically injected into the leg of a healthy dog, a watery solution of 7 centigrammes of cobra-poison with 2 decigrammes of Permanganate of potash at 8 56 A. M.

At 10-40 A. M. the respiration appeared to be somewhat hurried, but the dog subsequently exhibited no symptoms of cobra-poisoning. There was some swelling for a few days after the injection, but no sloughing of the part occurred. I saw this dog a fortnight afterwards, and it was perfectly well.

II.

Injected hypodermically a watery solution of cobra-poison, (7 centigrammes) with 2 decigrammes of Permanganate of potash, into the thigh of a healthy dog, at 9 A. M. Unaffected. This animal remained for some days under observation, but showed no signs of having been poisoned.

III.

At 9-16 A. M. injected hypodermically into the thigh of a healthy dog a watery solution of 7 centigrammes of cobra-poison.

9-23 A. M.—Hypodermically injected into the wounded part a solution of 2 decigrammes of Permanganate of

potash. I am by no means certain that I injected the permanganate efficiently.

9-52 A. M.—Frequent micturition.

10 A. M.—Extreme restlessness and salivation. 10-20 A. M. Breathing fast becoming embarrassed. Injected slowly into a vein 3 decigrammes of permanganate of potash in solution. Convulsions soon set in and the dog died at 10-30 A. M.—1 hour and 14 minutes after the injection. The animal was healthy, and weighed 48 lbs.

IV.

Injected into a small fowl an uncertain quantity of cobra-poison with a solution of the permanganate of potash.

Fowl unaffected.

V.

Hypodermically injected into a fowl 4 milligrammes of cobra-poison in solution with permanganate of potash. Remained unaffected. Killed it next day and found an extensive extravasation of blood of a tarry like appearance at the injected part

VI.

November 17th.—Mixed 4 centigrammes of dried cobra-poison with 1 gramme of glycerine. To this added 1 gramme of a 1 per cent solution of permanganate of potash, and injected the whole into the thigh of a sickly dog at 9-10 A. M. The usual symptoms of cobra-poisoning followed and the dog died at 11-15 A. M.—2 hours and 5 minutes after the injection.

VII.

At 9 30 A. M. hypodermically injected into the thigh of a very sickly dog 4 centigrammes of cobra poison in solution with glycerine and 3 decigrammes of salicylic acid.

10-40 A. M. Very restless, and urinating frequently; paralysis and convulsions soon followed, and the dog died at 11-45 A. M.—2 hours and 15 minutes after the injection.

VIII.

November 18th.—At 9-14 A. M. hypodermically injected into a fowl a glycerine solution of cobra-poison with a 1 *per cent* solution of permanganate of potash. After exhibiting all the characteristic symptoms of cobra-poisoning it died at 10-30 A. M.—1 hour and 16 minutes after the injection.

IX.

At 9-50 A. M. hypodermically injected into a small dog 3 decigrammes of fresh cobra poison mixed with 2 decigrammes of permanganate of potash in solution. On this occasion I used an ordinary glass syringe (the hypodermic syringe being out of repair at the time). Much of the solution escaped and the experiment is not very satisfactory. Unaffected.

November 19th.—Killed the dog and incised the part. Found very little extravasation at the injected part.

X.

At 10-15 A. M. hypodermically injected into a middling-sized fowl 8 milligrammes of fresh cobra-poison mixed with a solution of the permanganate of potash. Unaffected.

November 19th.—Unaffected.

„ *20th.*—Unaffected.

This fowl was kept under observation for 12 days, and remained in perfect health.

XI.

At 10-50 A. M. hypodermically injected into a full-sized healthy duck 3 centigrammes of fresh poison mixed with a solution containing 5 centigrammes of permanganate of potash. It walked away quite lame, and when it took to the water swam about with the uninjured leg. This duck was kept under observation for 10 days, but was not found to be affected.

XII.

November 19th.—At 9-28 A. M. injected hypodermically into a dog 7 centigrammes of cobra-poison rubbed up in a mortar with 3 decigrammes of permanganate of potash and 4 grammes of water. Unaffected.

20th November.—Unaffected.

XIII.

• At 9-34 A. M. injected into a sickly mangey dog 9 centigrammes of fresh cobra-poison mixed with 1.295 decigrammes of permanganate of potash in solution.

Unaffected

20th November.—Remained unaffected.

This animal remained unaffected.

XIV.

November 20th—Made a watery solution of cobra-poison and water 1.295 decigrammes of the former to 7.775 grammes of the latter.

Injected hypodermically one-third of the above solution into the leg of a large dog at 9-22 A. M.

9 25 A. M.—Applied a ligature above the injected part, but it was not very efficient. Then injected into the injured part 2.591 decigrammes of permanganate of potash in solution and similar quantites into other parts of the animal.

10-15 A. M.—Fell over and was very much convulsed.

10-30 A. M.—Dead—in 1 hour and 8 minutes.

XV.

Hypodermically injected another third of the above solution of cobra-poison into the thigh of a dog at 9-46 A. M.

10-27 A. M.—Convulsed.

10-35 A. M.—Dead—in 45 minutes.

XVI.

Mixed the remaining third of the above cobra-poison solution with 3 decigrammes of permanganate of potash

and injected the whole into the thigh of a small, sickly dog at 9-51 A. M.

10-50 A. M.—Partaking of food greedily.

November 21st.—Unaffected.

,, 24th.—Unaffected.

XVII.

With a view of testing the results of injecting Permanganate of potash alone, I injected hypodermically in the thigh of a large healthy dog 7.775 decigrammes (12 grains) of the agent in solution at 10-15 A. M. The dog became restless, but there was no other results.

At 3-39 P. M.—5 hours and 24 minutes after—hypodermically injected 32.395 milligrammes of cobra-poison in solution.

5 P. M.—The animal became very restless, and died during the night.

XVIII.

At 3 6 P. M. hypodermically injected into a small fowl a glycerine solution containing 5.399 milligrammes of cobra-poison mixed with 7 centigrammes of permanganate of potash.

3-20 P. M.—Suffering from all the symptoms of cobra-poisoning.

3-24 P. M.—Convulsed.

3-27 P. M.—Dead—in 21 minutes.

XIX.

Hypodermically injected into a large fowl 10.798 milligrammes of cobra-poison in solution with glycerine and permanganate of potash at 4-4 P. M.

5-30 P. M.—Convulsed.

6-40 P. M.—Dead—in 2 hours and 36 minutes.

XX.

21st November.—Made a watery solution of cobra-poison —7 centigrammes of the poison to 4 grammes of water. Hypodermically injected into the thigh of a healthy dog one-third of the above solution at 10-8 A. M. At 10-9

A. M., exactly one minute later injected into the injured part a solution containing 5.183 decigrammes of permanganate of potash and well pressed the part with my hand. Exhibited no symptoms of cobra-poisoning.

November 22nd.—Unaffected.

“ 24th.—Still unaffected except that the injected part had sloughed.

XXI.

Hypodermically injected one-third of the above solution into the thigh of a sickly dog at 10-21 A. M. Immediately injected 1.295 grammes æther and soon after a watery solution containing 4 decigrammes of permanganate of potash.

10 25 A. M.—Breathing rapidly and is much excited—apparently by the æther.

At 5-45 P. M. it became convulsed, and died at 7-30 P. M.—in 9 hours and 9 minutes.

XXII.

At 10-39 A. M injected into a vein of a dog the remaining one-third of cobra-poison solution mixed with 1.295 decigrammes of permanganate of potash. The dog was disinclined to take food, but was otherwise unaffected.

November 23rd.—Unaffected.

“ 24th.—Still unaffected : was released.

XXIII.

Made a solution with 7 centigrammes of cobra-poison and 2 grammes of water. For the first time in the course of my experiments I used cobra-poison which had not been collected by myself. I purchased this poison from a *kobiraj*. It appears to me that it had been mixed with strychnine. (If not the symptoms are certainly remarkable and most unusual. I feel certain however that strychnine had been mixed with it.)

Hypodermically injected one-third of the above solution into the leg of a fowl at 1-49 P. M.

1-50 P. M.—Was convulsed—every muscle in its body becoming rigid.

1-53 P. M.—Dead in 4 minutes. In this case the spasms were tonic, not clonic as is usual.

XXIV.

Hypodermically injected into the leg of a fowl one-third of the above solution at 1-55 P. M. Immediately injected into the same part a solution of permanganate of potash

1-57 P. M.—Fell over and was attacked with violent tonic spasms.

2-4 P. M.—Dead—in 4 minutes.

XXV.

Hypodermically injected into the leg of a fowl one-third of the above solution mixed with 1-295 decigrammes of permanganate of potash at 1-58 P. M. Beyond appearing to be a little drowsy this fowl was never affected. It remained several days under observation, and was never affected.

XXVI.

Hypodermically injected into a fowl an old solution containing 10.798 milligrammes of cobra-poison and 7 centigrammes of permanganate of potash. Never affected.

This fowl was never affected.

XXVII.

Hypodermically injected into the leg of a dog 7 centigrammes of the cobra-poison purchased from the *Kobiraj* with 1 gramme of water at 3-41 P. M. Exactly two minutes later hypodermically injected into the same part a solution containing 2 decigrammes of permanganate of potash. This dog was never affected, and it bolted on the morning of the 26th November.

XXVIII.

Hypodermically injected into a dog a solution containing 7 centigrammes of the same cobra-poison, at

3-48 P. M., and exactly two minutes later 2 decigrammes of permanganate of potash. Unaffected.

November 26th.—Unaffected.

,, 27th.—Unaffected ; released.

XXIX.

November 26th.—Mixed 1 295 decigrammes of the same cobra-poison with 3 grammes of water and hypodermically injected half of the solution into a dog at 9-52 A. M. Exactly 3 minutes after, hypodermically injected into the same part 2 decigrammes of permanganate of potash in solution, taking care that the agent came well in contact with the poison. I was astonished to find that while I was injecting the permanganate the dog became convulsed, every muscle being perfectly rigid. It was exactly as if the dog had been injected with a large dose of strychnine. Convulsions sometimes occur early in *Daboia*-poisoning and then pass off, and these spasms were distinctly tonic and most violent, and were not due to *daboia*-poison. This dog continued to have spasmoidic twitches, but was otherwise quite unaffected.

November 27th—Sluggish but otherwise unaffected.

,, 28th.—Well.

,, 29th.—Well.

,, 30th.—Well ; released.

XXX.

Hypodermically injected the remaining half of the poison solution into a dog's leg at 10-17 A. M. At 10-20 A. M., 3 minutes after, it had one violent tonic spasm of the muscles of the entire body, and they did not relax until after the dog died at 10 23 A. M.—only 6 minutes after the injection.

Note.—Finding I was getting short of cobra poison, and having had an offer of some from a *kobiraj*, I bought it. With this I mixed the remainder of the cobra-poison in my possession, making in all about 4 decigrammes. Observing that the poison was powdered and quite white, I

enquired the reason, and he explained the circumstance by stating that he had pulverized it Cobra-poison—that of the spectacled cobra—dries in yellowish crystals which form a white powder on pulverization and a green like fluid when mixed with water. This poison formed, however, a milky fluid on being mixed with water. It is clear to my mind that some other powerful poison was mixed with it either designedly or accidentally. Nevertheless the permanganate of potash possessed the power to neutralize both the cobra-poison and the other poison with which it had been mixed. I have not yet been able to see the *bokiraj* from whom I purchased the poison to obtain any explanation.

XXXI.

November 30th.—At 3-21 P. M. hypodermically injected into the thigh of a dog 5 centigrammes of cobra-poison (obtained from one of the cobras in my possession) mixed with 6 decigrammes of water.

At 3-25 P. M., exactly 4 minutes afterwards, commenced to inject hypodermically into the same part 2 decigrammes of permanganate of potash in solution. Well presssd the part with my hand. In the course of the day the dog appeared to be sluggish, but it showed no symptoms of cobra-poisoning.

December 1st.—Unaffected.

„ „ 3rd.—Unaffected ; released.

SUMMARY.

The results of these experiments—so far as they go—may be summed up thus : 20 dogs, 10 fowls and 1 duck were operated on. In 13 instances more than a fatal quantity of cobra poison (either dried or fresh) in solution with water was mixed with permanganate of potash and introduced either beneath the skin or into a vein, without symptoms of cobra-poisoning exhibiting themselves in a single instance In these 13 cases, 7 dogs, 5 fowls and one duck were operated on, (*vide* experiments

I, II, IV, V, IX, X, XI, XII, XIII, XVI, XXII, XXV, and XXVI.) In 4 instances a glycerine solution of cobra-poison was mixed with permanganate of potash and hypodermically injected : death resulted in every case. One dog and 3 fowls were used in the experiments (*vide* experiments VI, VIII, XVIII, and XIX. In one case, that of a dog (Expt. VII) salicylic acid was used with the poison, and death resulted. In another (Expt. XXI) the dog died after being first hypodermically injected with cobra-poison and then aether, and subsequently with permanganate of potash. In 7 cases the cobra poison was first injected hypodermically and subsequently the permanganate with the following results :—

Immediately after the poison—fowl—Expt. XXIV.				Result death.
1 minute after	„	dog	„ XX.	No symptoms.
2 minutes „	„	dogs	„ XXVII & XXVIII.	ditto.
3 „ „	„	dog	„ XXIX.	ditto.
4 „ „	„	„ „	XXXI.	ditto.
7 „ „	„	„ „	III.	Death.

In the first of these the dose was overwhelming and death ensued very rapidly, and in the last I am doubtful whether the agent was properly injected.

In experiment XIV the ligature was applied after the hypodermic injection of the poison, and then the permanganate of potash was injected, but it was very doubtful whether the ligature had been properly applied. The dog died. In the 3 cases in which the cobra-poison alone was injected death occurred (*vide* Expts. XV, XXIII and XXX) 2 dogs and 1 fowl were operated on. In Expt. XVIII the permanganate of potash was hypodermically injected some hours before the cobra poison, and the dog died. Except in 7 experiments, (XXIII, XXIV, XXV, XXVII, XXVIII, XXIX and XXX) the poison used was that collected by myself from various cobras (spectacled) in my possession. In every single instance the quantity of cobra poison injected was more than double or treble the quantity necessary to produce fatal

results. In 27 cases permanganate of potash was used and in 18 there was a total absence of symptoms of cobra-poisoning ; in 9 death resulted, but in 5 of these other agents besides the permanganate were used ; in one the permanganate was injected some hours before the poison, and in only 3 cases did the permanganate of potash seem to fail. Once when altogether overwhelming dose was injected into a fowl, once when the ligature had been applied with doubtful efficiency, and once when it was doubtful whether the agent had been so injected as to reach the poison lying in the tissues seven minutes after it had been injected. Experiment XIX amongst the recoveries is a very doubtful one.

Remarks.

I commenced these experiments after perusing the following extract which appeared in the Calcutta *Englishman* :—

EXTRACT.

A NEW CURE FOR SNAKE BITES.

“From a note to the Paris Academy, it appears that M. de Lacerda has discovered a fact of considerable scientific and practical importance to people in India, viz. that permanganate of potash counteracts very effectively the poison of serpents. In a first series of experiments a watery solution of the poison was injected into the cellular tissue of dogs under the legs, and its usual effects were large swellings, with abscesses, loss of substance, and destruction of tissues. But when an usual quantity of filtered (one per cent.) solution of permanganate of potash was injected one or two minutes after the poison, those local injuries were quite obviated ; there was merely a slight swelling where the syringe had entered. Next, introduction into the veins was tried, and the permanganate again succeeded admirably. In only two cases out of more than 30 was there failure, and this is

attributed to the animals being very young and weak and badly fed, also to the antidote being given at too long an interval after the poison, when the heart was already tending to stop. In one series of cases the permanganate solution was introduced half a minute after a solution of venom, and the animal showed no derangement beyond a very transient agitation and acceleration of the heart for a few minutes. In another series, the characteristic troubles caused by the poison were allowed to manifest themselves (dilatation of the pupil, quick breathing, and heart action, contractions, &c.) before the antidote was given. In two or three minutes, sometimes five, the troubles disappeared; a slight general prostration followed for 15 to 25 minutes, after which the animal would walk, and even run about, and resume its normal aspect. Other dogs poisoned similarly, but not receiving the antidote, died more or less quickly."

Before I can arrive at absolutely positive conclusions as to the practical value of the agent in Indian snake-poisoning, it will be necessary to test its power in varying quantities of cobra-poison and at varying intervals between the time of the injection of the poison and that of the injection of the permanganate—with and without the efficient application of the ligature. Experiments with viper-poison also will have to be performed since, as was clearly shown by Dr. Wall, the poisons of the cobra and the viper differ entirely in their physiological effects, the former acting upon special nerve centres in the medulla and the latter producing blood poisoning. As the Government of Bengal have been good enough to issue instructions with a view to my being furnished with some snakes, I purpose continuing the experiments. At this stage I think it advisable to confine myself as far as possible to a mere statement of facts. I may, however, state briefly what

conclusions seem to be warranted from the experiments which I have completed. I may remark that inasmuch as my experiments were prosecuted with cobra-poison, my conclusions can neither confirm nor controvert M. Lacerda's conclusions, as that gentleman experimented with poison other than that of the cobra, comparisons may, of course, be made.

My conclusions from these experiments are :—

I. That in dogs no appreciable symptoms of cobra-poisoning followed the hypodermic or intravenous injection of a watery solution of from 2 to 7 centigrammes of cobra-poison when previously mixed with from 1 to 3 decigrammes of Permanganate of potash, though under ordinary circumstances such quantities hypodermically injected are more than sufficient to produce fatal results.

II. That when similar quantities of a watery solution of cobra-poison were hypodermically injected into dogs, and were followed either immediately or after an interval of four minutes (the longest interval I have yet efficiently tested) by the hypodermic injection into the same part of a watery solution of permanganate of potash (1 to 6 decigrammes) no appreciable symptoms of cobra poisoning resulted.

III. That when glycerine was used instead of water to dissolve the dried cobra poison the permanganate of potash appeared to have no power over the virulence of the virus.

IV. That after the development of symptoms of cobra-poisoning the injection of permanganate of potash, whether hypodermic or intravenous, or both, failed to exercise any influence upon the symptoms.

V. That permanganate of potash possesses no prophylactic properties, since death followed the hypodermic injection of $3\frac{1}{2}$ centigrammes of cobra-poison in watery solution in the case of a dog which had been hypo-

dermically injected a few hours previously with 8 decigrammes of the agent in solution.

VI. That it would appear to be absolutely necessary that the permanganate to be efficacious should come into actual contact with the cobra-poison.

VII. That although no symptoms of cobra-poisoning followed the injection of cobra-poison and permanganate of potash, sloughing of the part injected sometimes followed.

VIII. That up to the present time it has never been experimentally shewn that any agent has either the power to neutralise the cobra-poison lying in the tissues, or to prevent death when four minutes had elapsed from the time of the injection of the poison to that of treatment.

IX. That if permanganate of potash has such power to destroy so subtle a poison as that of the cobra, it is probable that the hypodermic injection of the agent in the bite of a rabid animal would destroy the virus which causes that terrible disease.—*Hydrophobia.**

3rd December, 1881.

* I am aware that Mr. Condy recommends that the bitten parts should be washed with a solution of permanganate of potash, but in my opinion the procedure is altogether insufficient. The bitten part should be well hypodermically injected with a solution of permanganate of potash, 2 grains to one dram of water. The punctures should be well incised, and after being thoroughly washed with a similar solution, dressed with pulverized permanganate.—V. R.

2ND SERIES.

Cobra-poison.

XXXII.

Hypodermic injection of 7 centigrammes of poison, followed by the agent 5 minutes after; death.

9th December 1881.—Hypodermically injected into the thigh of a dog 7 centigrammes of dried cobra-poison in solution with 6 decigrammes of water, at 3-34 P. M.

3-39 P. M.—Commenced to hypodermically inject into the same part 3 decigrammes of permanganate of potash in solution. The dog struggled violently and snapped viciously. I doubt whether the whole of the permanganate of potash came in contact with the poison, though it may have done so.

5 P. M.—Restless.

10th December, 3 A. M.—Dead—after nearly 12 hours.

XXXIII. and XXXIV.

Hypodermic injection of one-half of the poison removed from the poison gland of a dead cobra, followed 5 minutes after by the injection of the agent. No symptoms of poisoning. Injection of the other half without the agent. Death.

December 11th, 1881.—A dead cobra having been brought to me, I excised its poison glands and pressed out the poison, which when dried weighed 8 centigrammes. This was dissolved in $1\frac{1}{2}$ grammes of water. After accurately dividing the solution into two equal quantities, the following experiments were performed.

XXXIII.

At 9-41 A. M. hypodermically injected into a large healthy dog, weighing 50 lbs., half of the above solution of cobra-poison.

XXXIV

At 9-43 A. M. hypodermically injected into a middle sized healthy dog, weighing 32 lbs., half of the above cobra-poison solution.

- 9-48 A. M.—Hypodermically injected into the same part 2 decigrammes of permanganate in solution. Whined a good deal when the agent was injected.
- 9-58 A. M.—Is extremely restless.
- 10-20 A. M.—Refused food. Salivated.
- 10-44 A. M.—Extremely restless.
- 12-57 P. M.—Convulsed.
- 4-22 P. M.—Dead—in 6 hours 41 minutes.
- 9-58 A. M.—Is lying down and is perfectly quiet.
- 10-20 A. M.—Quite quiet. Took the food refused by the other dog.
- 10-44 A. M.—Is perfectly quiet ; sleeping.
- 12-57 P. M.—Unaffected.
- 4-22.—Quite unaffected.
- December 12th.*—Unaffected except that the leg is swollen and somewhat painful. The part sloughed on the third day, but the animal was otherwise unaffected.
- December 26th.*—The wound having healed the animal was released.

XXXV.

Hypodermic injection of 5 centigrammes of poison followed by the injection of the agent 6 minutes after. No symptoms of poisoning.

Hypodermically injected into a dog, weighing 30 lbs., 5 centigrammes of cobra-poison in solution, at 10-20 A. M.

At 10-26 A. M. exactly 6 minutes afterwards, hypodermically injected into the same part 2 decigrammes of permanganate in solution, taking care to press the part well with my fingers.

1-55 P. M.—Unaffected. Partook of food.

3 P. M.—Quite quiet.

December 29th.—Bolted during the night.

30th.—Was seen in the bazar but could not be caught.

December 31st.—It was brought back. The little injured part was sloughing.

January 2nd, 1882.—Escaped.

XXXVI.

Hypodermic injection of 7 centigrammes of poison, followed by the injection of the agent 9 minutes after. Recovery.

January 6th.—At 3-59 P. M. hypodermically injected into the thigh of a healthy dog, weighing 44 lbs., 7 centigrammes of cobra-poison in solution.

4-8 P. M.—Hypodermically injected into the injured part 1.295 decigrammes of permanganate of potash in solution; the greatest care being taken that the agent reached the exact spot where the poison had been injected.

4-18 P. M.—Is drowsy and whining a great deal.

4-35 P. M.—Dozing and hanging down the head.

5 P. M.—Lying down and whining a great deal.

5-30 P. M.—Very drowsy, and hangs the head down almost to the ground. Starts up with a sudden jerk.

7th January.—Seems to be unaffected. The injected part is swollen.

The swelling was fomented with hot water and it gradually disappeared.

12th January.—The animal was perfectly well, and was released.

Note.—This dog was seen by me on the 15th January.—

Perfectly well.

XXXVII.

Hypodermic injection of 7 centigrammes of cobra-poison followed in ten minutes by the hypodermic injection of 1.295 decigrammes of the agent: death.

January 15th, 8-55 A. M.—Hypodermically injected into the thigh of a dog, weighing 32 lbs., 7 centigrammes of cobra-poison in solution.

9-5 A. M.—Hypodermically injected into the same part 1.295 decigrammes of permanganate of potash.

12-35 P. M.—Salivated. Convulsed.

3 P. M.—Lying down almost insensible. Breathing with difficulty. Heart beats small and rapid. Injected about 2 decigrammes of permanganate in weak solution.

3-15 P. M.—The breathing became somewhat easier but the tongue was paralyzed.

4-45 P. M.—Dead—in 7 hours 50 minutes,

Note.—The blood of this animal (while it was alive) was microscopically examined by Dr. Prockter and me, but we observed nothing abnormal,

XXXVIII.

Hypodermic injection of 7 centigrammes of cobra-poison, followed by the agent 6 minutes afterwards : death.

4-3 P. M.—Hypodermically injected 7 centigrammes of cobra-poison into a dog weighing 28 lbs.

4-9 P. M.—Injected 1.295 decigrammes of the agent into the same part.

5-10 P. M.—Convulsed.

5-30 P. M.—Much salivated.

6 P. M.—Dead—in 1 hour 57 minutes.

XXXIX.

Hypodermic injection of 3½ centigrammes of cobra-poison, followed in ten minutes by the permanganate : death.

16th January, 11-10 A. M.—Hypodermically injected into a sickly dog, weighing 40 lbs, 3½ centigrammes of cobra-poison in solution.

11-20 A. M.—Injected into the same part 2 decigrammes of permanganate in solution.

12-33 P. M.—Salivated.

12-45 P. M.—Convulsed.

12-56 P. M.—Dead—in 1 hour 46 minutes.

The following experiments were made with some cobra-poison which Mr. Boucher of Messrs. Scott Thompson & Co.'s very kindly gave me. He collected it him-

self, and although it was six years' old, it had retained all its original virulence.

19th January.

XL. and XLI.

Made a solution of 7 centigrammes of cobra-poison and divided it into two equal parts. One part was hypodermically injected into a dog : death. And the other half was hypodermically injected into a dog, followed eight minutes after by 2 decigrammes of permanganate. Serious symptoms of snake-poisoning terminating in recovery.

XL.

10-16 A. M.—Hypodermically injected into a dog, weighing 40 lbs., a solution of cobra-poison containing $3\frac{1}{2}$ centigrammes.

12-20 P. M.—Salivated.

1-5 P. M.—Convulsed.

1-10 P. M.—Much salivated.

1-20 P. M.—Dead—in 3 hours and 4 minutes.

XLI.

10-19 A. M.—Hypodermically injected into a dog, weighing 30 lbs., the solution of cobra-poison containing $3\frac{1}{2}$ centigrammes of the poison.

10-27 A. M.—Hypodermically injected into the same part a solution containing 1.295 decigrammes of the permanganate.

1 P. M.—Restless.

5-10 P. M.—Salivated.

5-48 P. M.—Lying down churning the froth from its mouth. Vomits occasionally.

6-15 P. M.—Vomited.

7-30 P. M.—Again vomited.

9-3 P. M.—Vomited.

20th.—Still very unwell ; vomited occasionally during

the day. The part is much swollen.

21st.—Vomited once or twice during the day. An abscess is forming at the injected part.

22nd.—The dog is much better. Opened abscess and applied creasote lotion.

This dog was kept under observation until the 26th, when it was released perfectly well.

XLII.

Hypodermic injection of cobra-poison : ligature: permanganate of potash : death.

20th January.—At 2-24 P. M. hypodermically injected into a dog, weighing 50 lbs., 7 centigrammes of cobra-poison.

2-26 P. M.—Applied an India rubber ligature. I am afraid it is not very efficient, as the rubber has given way in parts.

2-46 P. M.—Injected into the injured part 3 decigrammes of permanganate of potash in solution.

4-12 P. M.—Vomited.

4-20 P. M.—Salivated.

5-17 P. M.—Convulsed.

5-55 P. M.—Dead.

It is quite clear that in this case the ligature was inefficient.

XLIII.

Hypodermic injection of cobra-poison followed twelve minutes after by permanganate of potash : death.

At 2-58 P. M. hypodermically injected into a dog, weighing 34 lbs, $3\frac{1}{2}$ centigrammes of cobra-poison.

3-10 P. M.—Injected into the same part 2 decigrammes of permanganate.

4-20 P. M.—Convulsed.

4 47 P. M.—Dead—in 2 hours 49 minutes.

XLIV.

Intravenous injection of cobra-poison followed by the intravenous injection of permanganate of potash : death.

3-5 P. M.—Injected into a vein of a dog, weighing 20 lbs., 3 centigrammes of poison and immediately afterwards injected into the same vein 2 decigrammes of permanganate of potash in solution.

3-10 P. M.—Dead—in 5 minutes.

XLV.

Hypodermic injection of cobra-poison : ligature : permanganate of potash : artificial respiration : death.

January 22nd, 4-11 P. M.—Hypodermically injected into a dog weighing 26 lbs., $3\frac{1}{2}$ centigrammes of cobra-poison in solution.

4-14 P. M.—Applied a ligature of cloth which was found subsequently to have been torn.

4-31 P. M.—Cut into the part and injected permanganate of potash in all directions.

4-35 P. M.—Removed the ligature.

7-15 P. M.—Vomited.

8-3 P. M.—Vomited.

January 23rd, 7-50 A. M.—Convulsed. The animal was convulsed until 10 A. M. when I occasionally resorted to the direct method of artificial respiration. Whenever respiration was nearly suspended and the heart's action was ceasing the artificial respiration was had recourse to. In a short time respiration and the heart's action became normal. The animal was kept alive unfit 12-35 P. M., when the heart ceased to beat—in 20 hours 24 minutes.

XLVI.

Hypodermic injection of cobra-poison : ligature : permanganate of potash : no symptom of poisoning.

January 23rd, 11-48 A. M.—Injected 3 centigrammes of cobra-poison into a dog weighing 46 lbs.

11-51 A. M.—Applied a ligature.

12-6 P. M.—Injected the permanganate of potash into the affected part.

12-10 P. M.—Removed the ligature.

This animal was never affected. It was released on the 31st.

XLVII.

Hypodermic injection of cobra-poison : ligature : permanganate of potash : death.

January 24th, 2-24 P. M.—Injected into a dog, weighing 36 lbs., 2½ centigrammes of cobra-poison in solution.

2-28 P. M.—Applied a ligature made of chamois leather. The ligature broke and was reapplied.

2-54 P. M.—Injected the permanganate of potash into the affected part.

3 P. M.—Removed the ligature.

5-2 P. M.—Convulsed.

5-54 P. M.—Dead—3 hours after the injection.

XLVIII.

Hypodermic injection of cobra-poison followed by the injection of the permanganate of potash into the tissues considerably higher up than where the poison was injected : death.

At 2-34 P. M. hypodermically injected into the leg of a dog weighing 40 lbs. 2½ centigrammes of cobra-poison.

2-36 P. M.—Hypodermically injected into the thigh of the same leg, but quite away from the cobra-poison 3 decigrammes of permanganate of potash.

3-55 P. M.—Salivated.

4-17 P. M.—Convulsed.

4-39 P. M.—Dead—in 2 hours and 5 minutes.

XLIX.

Hypodermic injection of cobra-poison : ligature : permanganate of potash : serious symptoms of cobra-poisoning : recovery.

January 30th, 9-29 A. M.—Hypodermically injected into a dog $2\frac{1}{2}$ centigrammes of cobra-poison in solution.

9-32 A. M.—Applied a ligature above the part.

9-44 A. M.—Injected the part well with the solution of permanganate of potash.

9-50 A. M.—Removed the ligature.

5-12 A. M.—Vomited and was restless.

5-30 P. M.—Much salivated.

5-35 P. M.—Very restless.

31st.—Unaffected, only that its foot is swollen.
Perfectly recovered. Part subsequently sloughed.

L.

Hypodermic injection of cobra-poison : administration of "sure cure" from Africa : death.

At 10-4 A. M. hypodermically injected into a dog, weighing 28 lbs., a little less than 2 centigrammes of cobra-poison.

In four minutes incised the part, well rubbed in the "sure cure" as directed and administered to the animal 20 drops diluted with a small quantity of water.

1-52 P. M.—Convulsed. Administered 20 drops more of the "sure cure."

2-20 P. M.—Salivated.

3-45 P. M.—Dead—in 5 hours 41 minutes.

The supposed antidote had not the slightest effect. This case is given as a contrast to the permanganate cases.

LI.

Hypodermic injection of cobra-poison : ligature : permanganate of potash. No symptoms of poisoning.

27th January, 8-18 A. M.—Hypodermically injected into a dog 2 centigrammes of cobra-poison.

8-23 A. M.—Applied a catgut ligature—first having surrounded the limb with chamois leather.

8-36.—Injected the solution of the permanganate of potash, and soon after removed the ligature.

28th January.—Unaffected, except that the leg is swollen.

29th.—Unaffected.

This animal was never affected except that the injected part sloughed.

LII.

Notes mislaid, but 2 centigrammes of cobra-poison were injected, and five minutes after a catgut ligature was applied and 20 minutes subsequently permanganate of potash was injected. The part subsequently sloughed and the dog is still in my possession (February 8th). There were no symptoms of snake poisoning exhibited.

I think it is scarcely necessary to give any more experiments, as it is clearly demonstrated that the permanganate of potash—although it does not possess the power of an antidote in the ordinary sense of the word—is of very considerable value in the treatment of cobra-poisoning. Up to the present time the only really effectual means of treating cobra-poisoning were ligature and amputation. The permanganate of potash possesses the power of neutralising the cobra-poison while lying in the tissues, though it seems to have no power over the poison when it has been absorbed into the general circulation. It has not the slightest remedial influence when once the characteristic physiological effects of the cobra-poison are developed, and it is absolutely necessary that the permanganate should come into

actual and complete contact with the cobra-poison lying in the tissues, or the destruction of the cobra-poison will be incomplete. Sloughing is an almost constant sequence of the injection of the permanganate. Experiments XXXIII. and XXXIV. demonstrate clearly the effect of the hypodermic injection of the permanganate. The poison was removed from the glands of a cobra and one half was injected into one dog *weighing 50 lbs.*, and one half into another *weighing only 32 lbs.* No remedy was applied in the former case, and the animal died in 6 hours 41 minutes. In the latter case permanganate was injected 5 minutes after the injection of the poison, and although the animal was much weaker and smaller, it exhibited no symptoms of snake poisoning. Another excellent illustration is afforded by experiments L. and LI. Two dogs were injected each with a 2 centigramme solution of cobra-poison. In the one case a supposed "sure cure" sent from Africa was administered almost immediately after the injection, and the animal died in 5 hours and 41 minutes. In the other case five minutes after the injection a catgut ligature was applied, and thirteen minutes subsequently—that is eighteen minutes after the injection—a solution of permanganate of potash was injected and the animal showed no symptoms of snake-poisoning. Failure is generally explainable by inefficient ligature or incomplete injection of the permanganate. Some times, however, the intervals were too long or the dose of poison too large. But on this subject I shall have something to say when dealing with the treatment of snake poisoning. The best result was that in which a quantity of poison was injected into a dog sufficient to kill it in from five to six hours, and the ligature was applied five minutes after, followed by the injection of the permanganate of potash 20 minutes after—25 minutes from injection of cobra-poison to that of the permanganate of potash—and

the animal exhibited not a single symptom of snake-poisoning. It sometimes happens—either from inefficient ligature or from incomplete application of the permanganate—that a quantity of the poison will be absorbed, serious symptoms will result, but the animal will recover, as is demonstrated in experiments XXXVI., XLI. and XLIX. Or after several hours of suffering it may die, as demonstrated by experiment XLV. I have been assisted in these experiments by the Railway Native Doctor Tarini Prosuno Bhattacharjee, and I am under obligations to him for watching the animals in my absence and for handling the snakes for the extraction of the poison. I will deal with the treatment of cobra-poisoning in my next paper.

Before discussing the question of the best mode of treatment that can be adopted as suggested by the results of the experiments conducted by me, I will offer a few observations on the characteristic symptoms of Cobra-poisoning, and the chief diagnostic sign of an effective bite. Most authorities have given somewhat confused accounts of the symptoms of cobra-poisoning by erroneously assuming the identity of snake poisons, and by collecting together the various symptoms peculiar to all kinds of snake-poisoning my colleague, Dr. Wall, has very clearly demonstrated that the physiological effects of the poison of the cobra, and those of the poison of the *Daboia* differ so materially as to render it certain that they are two distinct poisons. The poison of the *krail* also appears to be very different from that of the *cobra*. It is with cobra-poison that I am now concerned, and it will be observed from the symptoms which I will describe that the poison expends all, or nearly all, of its force upon special nerve-centres in the *Medulla oblongata*. And it is this fact which probably explains the somewhat limited power of the Permanganate of potash over that particular poison—for the power is limited

to the destruction of the poison itself. The following are the symptoms of cobra-poisoning. Soon after the infliction of the bite there is experienced at the part a burning pain which gradually extends—sometimes to the throat and chest ; and the injected part commences to swell. There is nothing peculiar to be noticed about the fang marks, which may be scarcely, if at all, perceptible, or, one, two or even three or four punctures may be observed. Then comes a period—which may extend to four or five hours—during which no ill-effects are apparent. On an average this period of latency is, perhaps, in man, of from one to two hours' duration. Then commences a feeling of intoxication. The pupils are normal or, if anything, contracted. There is nothing at this time in the appearance of the patient to indicate that he is under the influence of the poison, and his intellect is perfectly clear. But power over the limbs now begins to be lost, and he staggers when attempting to walk. Then follow salivation, vomiting generally but not invariably, dropping of the jaw, paralysis of the lips, tongue and larynx. The urine contains no albumen, and the temperature is unaffected. The heart's action now becomes accelerated and the respiration more embarrassed, chiefly from the direct effect of the poison upon the nerve-centres of the *medulla*, but partly by mechanical obstruction from the collection of viscid mucus in the air passages. The patient is at this time usually very restless. The sight and hearing are apparently unaffected. There are occasional convulsive twitchings of the muscles, general convulsions may or may not supervene. The respiratory excursus is lessened, and the respiration gradually becomes slower and slower until finally it ceases altogether—the heart's action continuing for a few minutes longer. When the amount of poison injected is small serious symptoms may result, but the patient may ultimately recover. Such a case is the follow-

ing, which was described by me in the *Lancet* :—“ On the 28th August, I was sent for to see a man named Bámon Dás, aged forty years, who was said to have been bitten by a snake at 3 o'clock in the morning. On arrival I was informed that, having heard the rats making a great squeaking noise, and wishing to find out the cause, the patient had raised himself from the floor on which he was sleeping, when he felt something biting him on the left arm near the shoulder. He jumped up and saw a snake, which he was unable to identify, gliding from him towards a hole in the mat wall of his hut, through which the moon was shining. He thinks it was a *Téntuliâ Karis* (spectacled cobra of a tamarind color), about four feet long. He had been very ill indeed, much worse, it was said, than when I saw him. He had complained of feeling *nisha* (intoxicated), had vomited, and could neither stand nor speak though he had continued to be perfectly conscious. At 10 A. M., when I saw him, I noticed the following particulars : —He was being supported on the ground in a sitting posture by two men. Near the posterior border of the deltoid of the left arm were two rather indistinct, fang-marks, at some considerable distance from each other, as if the snake had failed at first to insert both fangs, and had then twisted its head and endeavoured to insert the other. One fang-mark, however, more resembled a scratch than a puncture. The arm was painful, hot, and swollen, measuring 11 inches in circumference, whereas the other arm, at a similar part, measured only $9\frac{1}{2}$ inches. On cutting through the puncture, around which the skin was raised to an extent corresponding to the size of a three penny bit, the track of the fang was clearly visible, though there was little infiltration into the subcutaneous areolar tissue, owing, no doubt, to the small quantity of poison that had been injected into it. The swelling was in some measure due to

ligatures that had been applied for a short time, above and below the bitten part. He had no power whatever over the eyelids, which had dropped, leaving only the lower part of the pupils visible. The pupils were perfectly natural, and the irides responded to light. When asked to identify people around him, he put his head back so as to bring the person in the line of vision. He could see perfectly well both those near him and those some distance off. The hearing was not affected. There was profuse salivation, the saliva streaming down from the corners of his mouth. The lower lip had dropped, as if he had lost all power over the *orbicularis oris* muscle. He could speak, but very indistinctly, so indistinctly that his friends had to ask him to repeat what he said : the intonation was peculiarly nasal, much resembling that of a person who had lost part of his palate. His lips were not used in his endeavours to tell me his name, consequently the labial "B" was omitted, and he answered with a very indistinct and nasal Aðn Dàs— for Bámón Dás. On attempting to swallow some water, it was returned through his nostrils. He was unable to clear his throat, which caused him some distress. Said he felt a difficulty in breathing though the respiration was but slightly embarrassed. The superficial temporal and frontal veins were very distinct and tortuous, being gorged with blood. He could not walk by himself, but if supported, walked with an unsteady gait, though he had perfect control over his upper extremities. Still felt intoxicated, and his body hot. Pulse 96, full and strong ; respiration 26 ; temperature 100-5°. Occasionally retching. He had no medicines, except a few innocent articles—such as cloves and ginger-tea—soon after he was bitten." From 12 o'clock he made a gradual recovery. His arm suppurated. There is a very small class of cases in which death rapidly results either from the injection of an unusually large

quantity of venom or from its direct injection into a vein. Such cases are extremely rare, and seldom, if ever, come under observation.

Sir Joseph Fayrer has described very minutely the local effects of the injection of the cobra-venom into the subcutaneous areolar tissue, and Dr. A. J. Wall has drawn attention to the diagnostic value of these local appearances.

On cutting into the injected part we shall find that the tissues have undergone changes varying with the amount of poison injected, and the time which has elapsed between the bite and our examination. If the bite is a poisonous one there will be either an effusion resembling red-currant jelly in appearance, or hyperæmia and a pink infiltration varying in intensity according to the circumstances above-mentioned. It is very generally and erroneously believed that the bite of the cobra proves fatal usually in from a quarter of an hour to an hour. As a fact, however, the interval between the bite and death is on an average much longer. On a reference to Sir Joseph Fayrer's "Thanatophidia," I find that the average time is about six hours. To kill a large-size dog (weighing 40 lbs.) in six hours it requires from $\frac{1}{3}$ to half a grain of cobra-poison. It is probable, therefore, that from a grain and a half to two grains are required to be injected to kill a man in six hours. And from experiments we find that that is about the average amount of poison injected by a cobra at one bite. Some cobras when fresh caught eject very little poison—sometimes none at all; the supply of poison depending upon circumstances into which it is not now necessary to enter. Bearing the above facts in mind, it will be conceded, I think, that the practical tests to which I have submitted the permanganate of potash have been fair and sufficient. Now, as to the treatment. If a reference is made to Dr. Ewart's essay on

the treatment of snake-poisoning contained in his work "On the Poisonous Snakes of India," which embodies all the recommendations made by those best able to give an opinion, it will be found that the only really efficient remedy recommended in an effective bite is the removal of the tissues in which the snake-poison is lying either by extensive cauterisation, excision, or amputation; very great stress is laid upon the importance of at once applying a ligature, and removing thoroughly and completely the whole of the affected tissues. Until I made these experiments I quite concurred in these recommendations when once an effective bite had been diagnosed. Now, however, I am quite convinced that such severe treatment is uncalled for. We have in permanganate of potash an agent which when properly used possesses the power of absolutely destroying the noxious properties of cobra-venom with comparatively little suffering to the patient and with little risk of extensive sloughing of the tissues. Our first object should, of course, be to prevent the absorption of the poison into the general circulation. The only known means to that end is the application of the ligature. I have found that the best material for a ligature is catgut—several strands of which should be covered with chamois leather. The ligature should be applied in the manner recommended by Sir Joseph Fayrer—*viz.*, it should be tied round the limb or member with a reef-knot and a stick should be inserted with a view to twisting the ligature as tight as possible. One ligature if well applied is sufficient—more multiplies the pain and swelling without affording any further safeguard against poisoning. The best position for a ligature is about four or five inches above the bite, and the time at which it is likely to be most effective is within five minutes of the infliction of the bite. A ligature should be applied in all cases. In the absence of such a ligature as I have above described, a piece

of stout cord or narrow pieces of cloth twisted together, might be used. It should not be forgotten that the ligature to be effective must be tightened with considerable force—a loose ligature is useless. The ligation of a limb or member is always attended with considerable pain which may be mitigated by a hypodermic injection of morphia. Having applied the ligature, the next step is the hypodermic injection of the permanganate of potash. The first question is, of what strength should the solution of the permanganate of potash be ? With a view to solving this question the following experiments were performed :—

1.

Mixed 0·12 per cent solution of Permanganate with $3\frac{1}{2}$ centigrammes of cobra-poison and injected into a fowl at 11-57 a. m.

12-10 p. m.—Dead in 13 minutes.

2.

0·25 per cent solution of Permanganate and $3\frac{1}{2}$ centigrammes of cobra-poison injected into a fowl at 11-54 a. m.

12-5 p. m.—Dead in 11 minutes.

3.

0·50 per cent solution of permanganate and $3\frac{1}{2}$ centigrammes of cobra-poison injected into a fowl at 11-51 a.m.

12-9—Dead in 18 minutes.

4.

1·50 per cent solution of permanganate of potash and $3\frac{1}{2}$ centigrammes of cobra-poison injected into a fowl, at 12-6 p. m.

1-5 p. m.—Dead in 59 minutes.

5.

2·0 per cent solution of permanganate of potash and $3\frac{1}{2}$ centigrammes of cobra-poison injected into a fowl at 12-1 p. m.

Somewhat sluggish but recovered.

6.

4 per cent solution of permanganate and 3½ centigrammes of cobra-poison injected into a fowl at 12-10 p. m.

Never affected.

While a 2 per cent solution may answer, it is safer in my opinion to employ a 5 per cent solution. *The solution must be thoroughly injected*—two or three drams of the solution being injected into the part which should be well pressed with the fingers. The ligature should not be removed until some minutes after the injection have elapsed. Should sloughing subsequently occur the case must be treated on general surgical principles.

